International Scholars Journals

Global Journal of Business Management ISSN 6731-4538 Vol. 11 (4), pp. 001-012, April, 2017. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Causality in mean and variance between ISE 100 and S&P 500: Turkcell case

Turhan Korkmaz[1]*, Emrah I. Çevik[1], Elif Birkan[2] and Nesrin Özataç[3]

[1]Department of Business Administration, Zonguldak Karaelmas University, 67100 Zonguldak, Turkey.
[2]Graduate School of Business, Zonguldak Karaelmas University, 67100Zonguldak, Turkey.
[3]Faculty of Business and Economics, Eastern Mediterranean University, North Cyprus.

Accepted 16 January, 2017

The article examines the causality between US stock market and Turkish stock market by using two-step method which is developed by Hong (2001). The returns of Turkcell securities that are traded as American Depository Receipt in the New York Stock Exchange and ISE 100 are used. The causality test results indicate that S&P 500 affects ISE 100 and Turkcell returns, moreover, Turkcell returns influence each other. Consequently, it can be seen that there is a spillover effect from US stock market to Turkish stock market.

Key words: Turkcell, S&P 500, ISE 100, ADR, causality.

INTRODUCTION

Since 1980's, due to the financial liberalization policies in developing and developed countries, investors have the opportunity to invest in international stock markets. There has been a great enhancement in the interaction between developing and developed countries with the global trade. Inevitably, the developed markets such as US stock market became an indicator for the developing markets and consequently, the price volatility in such markets directly began to affect the developing markets.

In this period, Turkey adopted liberalization policies and thus, the interest rates limitations were removed in 1980, foreign exchange was liberalized in 1984 and finally the limitations on capital movement were removed in 1989. In addition to all these, all the limitations in ISE regarding with trading securities as institutional or individual basis are removed in 1989. With this deregulation, the Turkish stocks and bonds were allowed to be traded internationally; hence the movement of capital and profit was liberalized.

The rise in the liberalization and the integration of the markets increased the causality among the markets. Most of the empirical studies on causality indicated that the developed countries' markets are dominant over developing countries' markets. The advances in information and communication technologies increased the trade operations forming integrated markets. Moreover, the securities of national firms in developing countries began to be traded in US market as an American Depository Receipt (ADR). Due to these improvements, this paper aims to investigate the causality of the returns of Turkcell stocks traded as ADR by using the two-step method developed by Hong (2001). Furthermore, the causality between Turkcell and ISE and also between ISE 100 and S&P 500 index is examined.

LITERATURE REVIEW

Alexander et al. (1988) examined the behavior of stock returns surrounding international listings for a sample of firms covering the period of 1969 to 1982. The main result of their paper is that international listing should lead

*Corresponding author. E-mail: korktur@yahoo.com, korktur@gmail.com. Tel: +90 533 726 4168. Fax: +90 372 257 6927.

to a decline in the expected return on the firm's common stock if capital markets were either completely or "mildly" segmented beforehand. Hamao et al. (1990) examine the transmission mechanisms of the conditional first and second moment in common stock prices across Tokyo, London and New York as international stock markets. The price volatility spillovers form New York to Tokyo, London to Tokyo and New York to London is observed. Lin et al. (1994) investigate empirically how returns and volatilities of stock indices are correlated between the Tokyo and New York stock markets. They found out that the foreign daytime returns can significantly influence the domestic overnight returns meaning Tokyo (New York) daytime returns are correlated with New York (Tokyo) overnight returns. They interpret this result as evidence that information revealed during the trading hours of one market has a global impact on the returns of the other market.

Webb et al. (1995) estimated the time structure of the relationship between daily US market and ADR returns and test whether the relationship varies according to the ADR country or region of origin. They find a strong significant relationship between ADR and US market daily returns on a contemporaneous and a one-day lagged basis, indicating a lead/lag relationship among equity markets, with the US market acting as the lead market in equity pricing. Karolyi and Stulz (1996) explored the fundamental factors that affect cross-country stock return correlations. Using a sample of all Japanese firms that traded in the American and New York Stock Exchanges as ADRs from 31 May, 1988 to 29 May, 1992, they construct overnight and intraday returns for a portfolio of Japanese stocks using their NYSE-traded ADRs and a matched-sample portfolio of US stocks. They found that US macroeconomic announcements, shocks to the Yen/Dollar foreign exchange rate and Treasury bill returns and industry effects have no measurable influence on US and Japanese return correlations. Kanas (1998) examined the issue of volatility spillovers across the three largest European stock markets, namely London, Frankfurt and Paris for the period 1 January, 1984 to 7 December, 1993. During the period reciprocal spillovers are found to exist between London and Paris and between Paris and Frankfurt and unidirectional spillovers from London to Frankfurt. In almost all cases, spillovers are asymmetric in the sense that bad news in one market has a greater effect on the volatility of another market than good news.

Martell et al. (1999) examined risks and returns of Latin American stocks following ADR listings in US equity market and found no systematic change in their volatility. Their findings differ from previous results for ADR introduction to European and Asian stocks, although it is consistent with several prior findings on international stock listings. They attribute the different results of the studies to be partly due to the Latin American domestic equity market hours being similar to those of the USA, whereas the Asian and European markets are open while the US markets are closed. Foerster and Karolyi (2000) examined ADR returns for a full three years from the issue date and found the 333 ADRs underperformed just as initial public offerings (IPOs) underperform in the long run. Their sample covers the time period from 1982 through 1996 and included ADRs from 35 countries in Asia, Latin America and Europe. The underperformance of the ADR sample is 1.13% for one month, 4.07% for 12 months and 14.99% for 36 months compared to the domestic market index. When compared to a US index, the underperformance for the ADRs totals 27.53% for the three-year holding period. Alaganar and Bhar (2002) examine the information flow between dually listed stocks traded in Australia and the US as ADRs for the period of 1 January, 1994 to June, 2000. Their results indicated unidirectional information flow from the US equity market to the Australian market both with the dually listed stocks and the stock indices.

Xu and Fung (2002) examined patterns of information flows for Chine-backed stocks that are cross-listed on exchanges in Hong Kong and New York for the period January, 1994 to May, 2000. Their results analyzing the dual-listed stocks indicate significant mutual feedback of information between domestic (Hong Kong) and offshore (New York) markets in terms of pricing and volatility. Stocks listed on the domestic market appear to play a more significant role of information transmission in the pricing process, whereas stocks listed on the offshore market play a bigger role in volatility spillover. Schaub (2003) investigates the early and long-run abnormal returns of foreign equities traded as ADRs on the NYSE for January 1, 1987 through May 31, 1998. His study provides the evidence that the US markets overprice ADRs in the short and long term. The underperformance of ADRs is most severe for IPO issues as compared to seasoned equity offerings (SEOs), emerging market issues as compared to developed market issues and Latin American ADRs as compared to those issued by firms' headquarter in Europe and the Asia Pacific region. Kadapakkam and Misra (2003) examine the linkages between returns on Indian global depositary receipts (GDRs) in London and their underlying stocks in India for the period of August, 1996 to December, 2001. They report a feedback effect in information flows between the Mumbai (formerly Bombay) and London markets. The impact of the Mumbai (home) returns on the subsequent London (offshore) returns is significant both economically and statistically, whereas the impact from London returns to Mumbai returns is relatively small.

Alaganar and Bhar (2004) examine the effect of international listing on the conditional return distribution of Australian stocks in the domestic market for the years 1981 to 1996. Although they find evidence of statistical shift in the characteristics of the return distribution from individual stocks, there is no systematic market-wide pattern in the impact. Their results imply the Australian equity market is globally integrated and priced efficiently and the benefits of dual listing, if any, tend to be firm-specific.

Ejara and Ghosh (2004) investigate the impact of ADR listing on the trading volume and volatility of the domestic market for the period of December 1994 and July 1997. The analyses provide empirical evidence showing increase in both trading volume and price volatility in the domestic market after ADR listing. The increase in volatility is attributed to noise resulting from public information as opposed to increased trading friction. This suggests improvement in liquidity following ADR listing. Shaub (2004) tests early and aftermarket returns of Asia-Pacific and European equities traded on the New York Stock Exchange as ADRs for the period of 1 January, 1987 through 30 September, 2000. His results provided evidence that the US markets overpriced on the average the Asian ADRs. However, while the sample of Asia-Pacific equities issued from January, 1987 through May, 1998 underperformed the S&P 500 by almost 23%, the ADRs issued from May, 1998 through September, 2000 returned roughly the same as the S&P 500 for the three-year bear market holding period. These results may suggest timing of Asia-Pacific ADR issuance affects excess returns over the S&P 500 in the long run. On the other hand, the performance of the European ADR sample was roughly the same as the S&P 500 regardless of the time it was issued. Mak and Ngai (2005) examine patterns of information flows related to both pricing and volatility spillover across markets focusing on China-backed stocks, which are listed on both the Hong Kong Stock Exchange (HKSE) and the NYSE for the period of 9 June, 1994 to 31 December, 2003. Results indicate a significant mutual feedback of information between Hong Kong–listed stocks and ADRs. The Hong Kong market appears to play a more important role in influencing the pricing of corresponding companies in the US market, whereas both markets are similarly influential to the volatility spillover.

Schaub and Rao (2006) examine the initial two-week excess performance relative to the S&P 500 Index of ADRs listed on the NYSE form January, 1987 to September 2001 to determine whether short-term wealth effects exist. According to their findings, they suggest that the initial excess performance was not significant. However, after segmenting the sample, emerging market ADRs significantly outperformed the S&P 500 by over 3% while developed market ADRs underperformed by 0.92%.

Yang (2007) applies a statistical procedure to test the dependencies and direction of inter-day spillover effects between the ADRs and their underlying shares on two nonsynchronous international markets for the ADRs and their underlying stocks on the Tokyo Stock Exchange and the NYSE and NASDAQ for the period of 2 September, 1993 to 3 November, 2003. The empirical results provide evidence of contemporaneous return and volatility spillovers from Tokyo to New York and vice versa. In the lagged spillover test, the evidence also suggests that the dominant market (home market) adjusts to the information from the satellite market (foreign market) in an efficient manner. Schaub (2007a) examines New York Stock Exchange-listed ADRs from industrial firms to determine overall short and long-term investment performance and whether the level of issue (emerging versus developed) or timing of issue (before or during the US bear market) affects ADR performance relative to the S&P 500 for 1 January, 1990 through 31 December, 2002. Early performance results suggest a slight underperformance by the industrial portfolio; however, emerging issues significantly underperform the market index while developed issues outperform the S&P 500 during the first month of trading. After three years of trading in the US markets, industrial ADRs return roughly the same as the S&P 500. These results provide evidence that level and timing of issue affect portfolio returns when investing in industrial ADRs.

Schaub (2007b) seeks to determine whether a similar diversification effect is provided by NASDAQ listed firms, which tend to be smaller and have more return volatility for the period of January 1, 1990 through 31 December, 2002. The return results are broken down to distinguish differences in long-term excess returns of ADRs issued and traded during the U.S. stock market boom and those with a three-year holding period that includes the US bear market. The results are further segmented into those ADRs issued in developed economies versus those issued by firms headquartered in emerging markets.

METHODOLOGY

Traditional granger causality test focuses on the mean changes, while the causality-in-variance examines the conditional volatility depen-dence between two variables. However, causality-in-variance is important because it implies a general pattern to volatility transmission and because volatility can be transmitted between markets whose returns are either statistically uncorrelated or exhibit no causality-in-mean. This information will enhance the volatility of forecasting in foreign markets by academics and practitioners and will be of interest to traders and asset managers – knowledge of the timing and direction of transmission facilitating the assumption of hedge positions in response to foreign information shocks (Li et al. 2008). Therefore in this study we examine the causality between US stock market and Turkish stock market by using two-step method.

Cheung and Ng (1996) proposed a two-step test procedure to examine causal relationship between time series. The main advantage of this test is the flexible specification of the innovation process and the non-dependence on normality. This procedure based on Cross-Correlation Function (CCF) of the standardized residuals of GARCH model. The test statistic is defined as:

$$S = T\sum_{j=1}^{M} \hat{\rho}_{uv}^{2}(j) \qquad (1)$$

Where, $\hat{\rho}_{uv}^{2}(j) = \{\hat{C}_{uu}(0)\,\hat{C}_{vv}(0)\}^{-1/2}\,\hat{C}_{uv}(j)$, $\hat{C}_{uu}(0) = T^{-1}\sum_{t=1}^{T}\hat{u}_t^{2}$, $\hat{C}_{vv}(0) = T^{-1}\sum_{t=1}^{T}\hat{v}_t^{2}$ and sample cross-covariance function is defined as:

$$\hat{\rho}_{uv}(j) = \begin{cases} T^{-1} \sum_{t=j+1}^{T} \hat{u}_t \hat{v}_{t-j}, & j \geq 0 \\ T^{-1} \sum_{t=j+1}^{T} \hat{u}_{t+j} \hat{v}_t, & j < 0 \end{cases} \quad (2)$$

In Equation (2), $\hat{u}_t$ and $\hat{v}_t$ are standardized residuals obtained from GARCH model testing causality-in-mean (squared standardized residuals is used testing causality-in-variance). S statistic is asymptotically χ^2_M, the null hypothesis that there is no causality-in-mean or variance.

The criticism of the *S* test statistics is that it may not be fully efficient when a large M is used because it gives equal weighting to each of the M sample cross-correlations. However, empirical stu-dies exhibit that cross-correlation between financial assets decay to zero when lag order j is increased. Hong (2001) modified Cheung and Ng test statistics by using non-uniform kernels weighting func-tion. He indicated that his test statistic in which the null hypothesis shows that there is no causality outperform in the Monte Carlo simulation studies. The Hong's (2001) test statistics is defined as:

$$Q_1 = \frac{T \sum_{j=1}^{T-1} k^2 \frac{j}{M} \hat{\rho}_{uv}^2(j) - C_{1T}(k)}{\sqrt{2 D_{1T}(k)}} \quad (3)$$

Where $k(j/M)$ is a weight function, for which we use the Barlett kernel[1]

$$k(j/M) = \begin{cases} 1 - |j/(M+1)| & if \ k/(M+1) \leq 1 \\ 0 & otherwise \end{cases} \quad (4)$$

and

$$C_{1T}(k) = \sum_{j=1}^{T-1} \left(1 - |j|/T\right) k^2 \left(j/M\right) \quad (5)$$

$$D_{1T}(k) = \sum_{j=1}^{T-1} (1 - |j|/T)\{1 - (|j|+1)/T\} k^4 (j/M) \quad (6)$$

Q_1 test statistics is a one-sided test and upper tailed normal distri-bution critical values should be used. For example, the asymptotic critical value at the 5% level is 1.645. The test procedure is summarized by Hong (2001) is given as:

(1) Estimate univariate GARCH (p, q) models for time series and save the standardized residuals.

(2) Compute the sample cross-correlation function $\hat{\rho}_{uv}(j)$ between the centered standardized residuals.

(3) Choose an integer M and compute $C_{1T}(k)$ and $D_{1T}(k)$.

Compute the test statistic Q_1 and compare it to the upper-tailed critical value of normal distribution at an appropriate level. If Q_1 is larger than the critical value, then there is no causality and accordingly, the null hypothesis is rejected. An interesting feature of asset prices is that "bad" news seems to have a more pronounced effect on volatility than "good" news. For many stocks, there is a strong negative correlation between the current return and the future volatility. The tendency for volatility is to decline when the return rises and when it rises the return falls which is called the leverage effect (Enders, 2004). In this study we obtain standardized residuals from EGARCH model to consider asymmetric effect on the stock volatility. Exponential GARCH (EGARCH) model proposed by Nelson (1991) allows effects of good and bad news on volatility. The specification for the conditional variance is:

$$\log(\sigma_t^2) = \omega + \sum_{j=1}^{q} \beta_j \log(\sigma_{t-j}^2) + \sum_{i=1}^{p} \alpha_i \left| \frac{\varepsilon_{t-i}}{\sigma_{t-i}} \right| + \sum_{k=1}^{r} \gamma_k \frac{\varepsilon_{t-k}}{\sigma_{t-k}} \quad (7)$$

In the EGARCH model the sum of α_i and β_i measures the persistence of volatility for given a shock. Because the left-hand side is the log of the conditional variance, leverage effect is exponential and that forecasts of the conditional variance which is guaranteed not to be negative. The presence of leverage effect can be tested by the hypothesis that $\gamma_i < 0$. The asymmetric effect exists, if $\gamma_i \neq 0$. However, Van Dijk et al. (2005) and Rodrigues and Rubia (2007) show that two step causality-in-variance test developed by Cheung and Ng (1996) and Hong (2001) suffer from severe size distortions in the existence of structural breaks in the volatility. Therefore, we examined the presence of structural breaks unconditional variance of return series before testing causality-in-mean and variance.

Inclan and Tiao (1994) proposed a method that based on ICSS to detect structural breaks in the unconditional variance of a stochastic process. In order to test null hypothesis of constant unconditional variance against the alternative hypothesis of a break in the unconditional variance, Inclan and Tiao (1994) proposed using the statistic given by:

$$IT = \sqrt{T/2} D_k \quad (8)$$

Where $D_k = (C_k / C_T) - (k/T)$ and $C_k = \sum_{t=1}^{k} r_t^2$ be the cumulative sum of squares of a series of uncorrelated random variables with mean 0 and variance σ_t^2, t = 1, 2, ...,T.

The value of k (k = 1,K, T) that maximizes $|\sqrt{T/2} D_k|$ is the estimate of the break date. Under the variance homogeneity IT statistics behaves like a Brownian bridge asymptotically. At the 5% significance level, the critical value computed by Inclan and Tiao (1994) is $C_{0.05} = 1.358$. The most serious drawbacks of the IT test statistics are designed for independently and identically distributed random variables. This is a very strong assumption for financial data as most return series include conditional heteroskedasticity. For this purpose, Sanso et al. (2004) modified IT test statistics for conditional heteroskedasticity. Modified IT test statistics given by

$$\kappa_2 = \sup_k \left| T^{-1/2} G_k \right| \quad (9)$$

Where $G_k = \hat{\omega}_4^{-1/2} \left(C_k - \frac{k}{T} C_T \right)$, $\hat{\omega}_4$ is a consistent estimator of ω_4. Non-parametric estimator of ω_4,

$$\hat{\omega}_4 = \frac{1}{T} \sum_{t=1}^{T} (r_t^2 - \hat{\sigma}^2)^2 + \frac{2}{T} \sum_{l=1}^{m} \omega(l,m) \sum_{t=l+1}^{T} (r_t^2 - \hat{\sigma}^2)(r_{t-1}^2 - \hat{\sigma}^2) \quad (10)$$

Where $\omega(l,m)$ is a lag window, such as the Barlett, defined as

[1] In this study, we used Barlett kernel because Hong (2001) shows that several nonuniform kernel is performed similar results.

Table 1. Explanations of the variables.

Variable	Explanation
S&P 500	Standart and Poors Index ($)
ISE 100	Istanbul Securities Index - 100 Index (TL)
TKC	Returns of Turkcell traded as ADR at NYSE ($)
TCELL	Returns of Turkcell traded at ISE (TL)

$\omega(l, m) = 1 - l/(m+1)$, or the quadratic spectral.

In the test procedure, if we are looking for only the possibility of single point change, then the G_k function would provide a satisfactory procedure. But when we are interested in finding multiple change points on an observed series the usefulness of the G_k function becomes questionable because of the masking effect. A solution is an iterative scheme based on successive application of G_k to pieces of the series, dividing consecutively after a possible change point is found[2] (Inclan and Tiao, 1994).

DATA AND EMPIRICAL RESULTS

This study examines the causality between the returns of Turkcell traded at Istanbul Stock Exchange Market (ISE) and also at New York Stock Exchange (NYSE) as ADR. The daily closing prices for the period between 07/11/2000 and 06/01/2009 are used. The closing prices of Turckell securities traded at ISE are obtained from http://analiz.ibsyazilim.com, the closing prices of ISE 100 index are obtained from Central Bank of the Republic of Turkey (CBRT). The closing prices of Turkcell as ADR and S&P 500 index are obtained from http://finance.yahoo.com. The closing prices of the variables are formulated as a return series of;

$r_t = 100 \cdot \ln(p_t / p_{t-1})$ and used for the analysis. The explanations of variables are given in Table 1.

The descriptive statistics that belong to variables are given in Table 2. The average return of ISE 100, TKC and TCELL is positive whereas the average return of S&P 500 index is negative. TCELL is found the most volatile securities in the sample according to standard deviation. ISE 100, S&P 500 and TCELL returns show negative skewness. According to the Jarque-Bera normality test statistics, all of the return series exhibit significant deviation from normality. Kurtosis statistics indicate that the return series tend to fatter tail distribution than a normal distribution. Also LM statistics that test whether conditional volatility in the return series indicate existence of ARCH effect.

Van Dijk et al. (2005) indicate that if there is a structural break in the series, the two-step causality tests suffer from size distortions. Therefore, break in variance test is applied in the first step which is developed by Sanso et al. (2004) and the results are given in Table 3 and Figure 1.[3] According to the break test results, there are 2 breaks in TCELL's variance, 3 breaks in ISE 100, 4 breaks in TKC and 6 breaks in S&P 500's. Although TCELL and TKC are same securities, we determine different numbers of break and breaks date in the variance of TCELL and TKC. It can be expected because there are some differences between TCELL and TKC. For instance, price of TCELL is in Turkish Lira and price of TCK is in US Dollars. Secondly, TCELL and TCK are traded in Turkish and US markets and are affected from traded markets differently. Nouira et al. (2004) proposed a method to eliminate the effect of structural break in variance. Unconditional variance σ_t^2 and break points are given as:

$$\hat{\sigma}_t^2 = \sum_{i=0}^{k} \hat{\sigma}_i^2 \, I\left(t_i^* \le t \le t_{i+1}^*\right) \quad (11)$$

Where k represents the break point and variance is given as $\hat{\sigma}_i^2 = \left(1/\left(t_{i+1}^* - t_i\right)\right) \sum_{t=t^*}^{(t_{i+1}^*)-1} r_t^2$ (t=1, …, n and i=0, …,k). $I(.)$ is a dummy variable and it is taking on a value of 1 if argument is true and 0 otherwise. In order to eliminate the effect of the structural break, the return series are filtered as $rf_t = r_t / \hat{\sigma}_t$ (t=1, …, n) and causality test is applied according to the filtered series.[4] The existence of the unit-root is investigated by ADF which is developed by Dickey and Fuller (1979), PP test by Phillips and Peron (1988) and KPSS test by Kwiatkowski et al. (1992). The test results shown in Table 4 indicate that return series are found stationary.

First, in order to test the causality-in-mean and variance, EGARCH model is employed and the results are given in Table 5. The Akaike's information criterion is used to

[2] See Inclan and Tiao (1994) for ICSS procedure details.

[3] The existence of the structural break in the return series is investigated with multiple structural break test which is developed by Bai and Perron (1988 and 2003). The test results show that there is no break in the mean of the return series. The results are available on request.

[4] For the filtered return series variance break test is reapplied and the existence of the break is not observed. The results are available on request.

Table 2. Descriptive statistics.

Statistic	ISE 100	S&P 500	TKC	T CELL
Sample size	1968	1968	1968	1968
Sample period	07/11/2000 06/01/2009	07/11/2000 06/01/2009	07/11/2000 06/01/2009	07/11/2000 06/01/2009
Mean	0.035	-0.021	0.023	0.040
Standard deviation	2.652	1.374	3.911	3.520
Skewness	-0.221	-0.144	0.185	-0.120
Excess kurtosis	7.579*	10.579*	6.132*	5.274*
J-B	4726.891*	7455.185*	3095.482*	2285.746*
ARCH (5)	57.201*	164.25*	19.338*	41.404*
Q (20)	34.045	89.558*	30.186	37.716*
Q_S (20)	492.700*	3190.24*	401.590*	476.021*

Notes: J-B indicates Jarque-Bera normality test, ARCH (5) indicates LM conditional variance test, Q (20) and Q_S(20) indicates Box-Pierce serial correlation test for return and squared return series respectively. *Indicates significance at 1% level.

Table 3. Break in variance test results.

Test	ISE 100	S&P 500	TKC	TCELL
Number of break	3	6	4	2
Break date	17/09/2001	28/06/2002	06/12/2001	06/12/2001
	14/04/2003	17/10/2002	17/11/2004	21/03/2003
	10/09/2008	02/04/2003	29/06/2007	
		25/07/2003	12/09/2008	
		09/07/2007		
		12/09/2008		

determine the best model that describes the data. According to EGARCH model with generalized error distribution (GED) results in Table 3, the best model for S&P 500 is ARMA(1,3)-EGARCH(2,1), and for ISE 100, ARMA(2,2)-EGARCH(1,1), for TKC, ARMA(2,1)-EGARCH(1,1) and for TCELL, ARMA(3,3)-EGARCH(1,1)models are decided. In all models, ARCH and GARCH parameters are found statistically significant at 1% level. The β parameter, that is, the indicator of the persistence in volatility is found between 0.809 and 0.909. Except TCELL, γ parameter is found statistically significant. Negative statistically significant γ parameter indicates that-existence of leverage effect in return series. GED parameter is found statistically significant and lower than 1.5; it shows that distribution of residuals is leptokurtic.

In order to test the causality-in-mean, standardized residuals are used from EGARCH models and cross-correlation functions are estimated. In this study, Q_1 test is estimated for a week (M = 5), for two weeks (M = 10), for three weeks (M = 15) and one month (M = 20) and the results given in Table 6. According to the causality-in-mean test results, S&P 500 index is found as the Granger cause of ISE 100, TKC and TCELL. In other words, ISE 100 index and the return of Turkcell firm are influenced by S&P 500 index returns. Among Turkcell returns, there are strong feedback and this affects each other. While ISE 100 index is not the Granger cause of the TCELL return then the TKC return is influenced in a long time as three weeks. However, the return of TKC is found as the Granger cause of ISE 100 index. Cheung and Ng (1996) pointed out that result from test of causality-in-variance between two different return series are affected when there is causality-in-mean. Gebka and Serva (2007) used an approach to remove any potentially remaining causality in mean by including lagged returns from the second market as explanatory variables into first market's mean equation. Following the same method, lagged returns of variable that is found as a Granger cause is included to EGARCH model as explanatory variables.[5]. Except S&P 500 return series EGARCH model is re-estimated and causality-in-variance test is employed. Q_1 test statistics

[5] For example, according to the causality-in-mean test, S&P 500 index is found the Granger cause of ISE 100 index. Therefore before causality-in-variance test is applied, lagged term of S&P 500 is included in ISE 100 mean equation as explanatory variables.

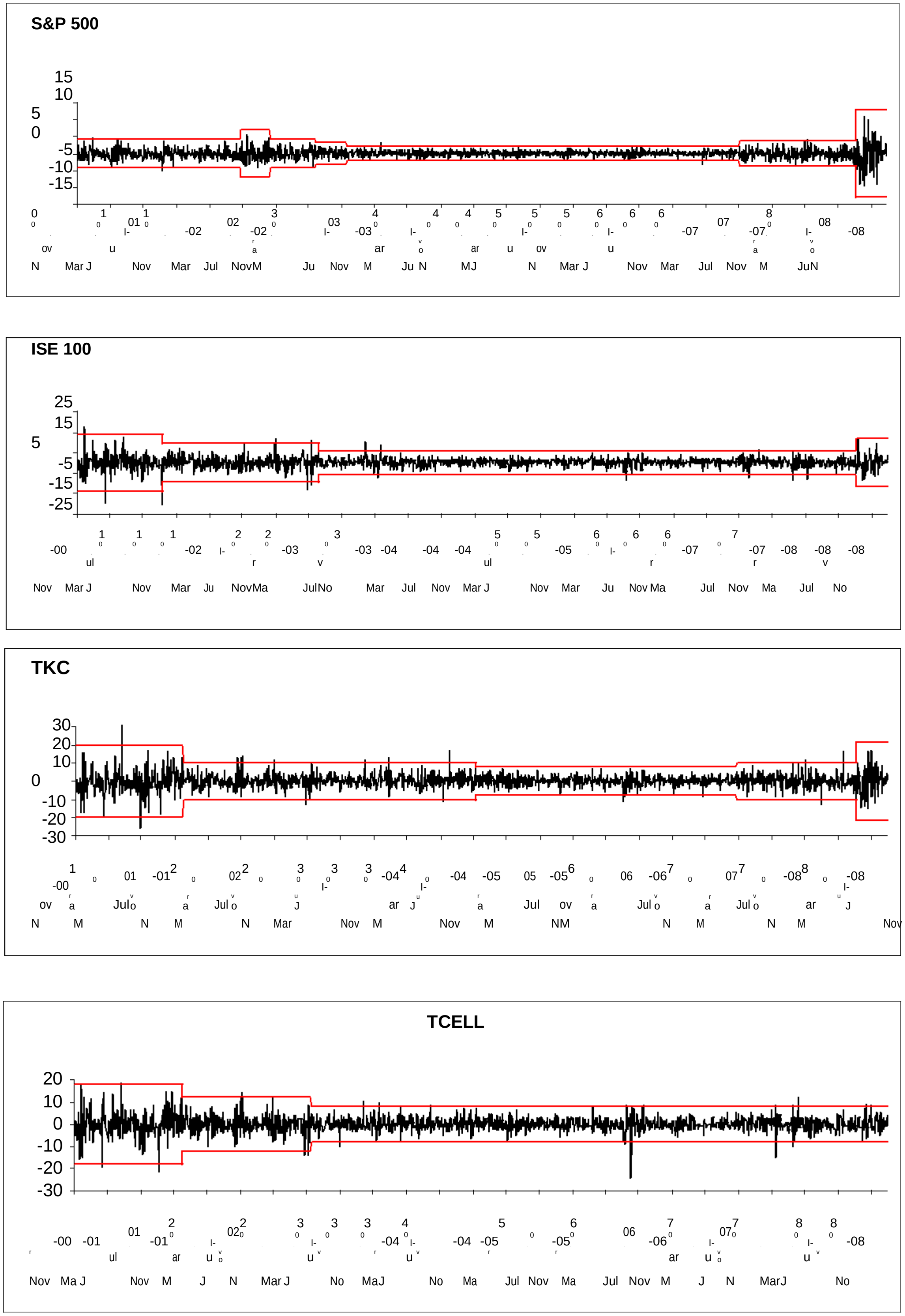

Figure 1. Daily returns of four equity returns. Notes: The straight lines shown are ± 3 standard deviation during each regime.

Table 4. Unit root test results.

Index	ADF	PP	KPSS
S&P 500	-48.101*	-48.442*	0.236*
ISE 100	-43.340*	-43.329*	0.175*
TKC	-44.489*	-44.508*	0.207*
TCELL	-42.902*	-43.054*	0.101*

Notes: *Indicates stationary at 1% level.

Table 5. EGARCH model results.

Variable	ISE 100	S&P 500	TKC	TCELL
Constant	0.031	0.017	0.037***	-0.001
AR(1)	-0.223*	0.687*	0.959*	-0.043
AR(2)	-0.898*	-0.973*	0.034***	0.299
AR(3)		0.452*		0.529*
MA(1)	0.255*	-0.768*	-0.996*	0.073
MA(2)	0.911*	0.996*		-0.324
MA(3)		-0.504*		-0.576*
ω	-0.153*	-0.051*	-0.110*	-0.265*
α_1	0.187*	-0.288*	0.146*	0.332*
α_2		0.344*		
β	0.869*	0.916*	0.899*	0.794*
γ	-0.088*	-0.119*	-0.042***	0.011
v	1.437*	1.601*	1.201*	1.286*
Log-like	-2692.770	-2701.803	-2686.546	-2654.509
ARCH (5)	0.088 [0.994]	1.137 [0.338]	0.262 [0.933]	0.846 [0.516]
Q (20)	-0.008 [0.195]	0.013 [0.039]	-0.013 [0.168]	-0.029 [0.214]
Q_S (20)	0.005 [0.900]	0.003 [0.151]	-0.037 [0.463]	-0.004 [0.000]

Notes: v indicates GED parameter, Log-like indicates Log likelihood value, ARCH(5) indicates LM conditional variance test, Q(20) and Q_S(20) indicates Box-Pierce serial correlation test for return and squared return series respectively. *, ** and *** indicates significance levels at 1, 5 and 10%, respectively.

Table 6. Causality-in-mean test results.

Causality direction	M = 5	M=10	M=15	M=20
	Q_1			
S&P 500 - ISE 100	64.355*	50.040*	42.066*	36.935*
ISE 100 – S&P 500	-0.065	0.156	0.580	0.764
TCELL -TKC	7.914*	6.213*	5.669*	5.302*
TKC - TCELL	31.564*	24.743*	20.859*	18.282*
S&P 500 -TKC	3.524*	2.323**	1.881**	2.018**
TKC – S&P 500	-0.643	-0.058	0.439	0.642
ISE 100 -TCELL	-0.863	-0.642	-0.076	0.263
TCELL - ISE 100	-0.341	0.240	0.806	1.038
S&P 500-TCELL	36.880*	28.713*	24.316*	21.604*
TCELL –S&P 500	-0.594	0.167	0.971	1.313
ISE 100 - TKC	1.217	1.478	2.406*	2.952*
TKC -ISE 100	19.528*	15.398*	13.253*	11.866*

Notes: * and ** indicates significant causality relationship effect at 1 and 5% level respectively.

Table 7. Causality-in-variance test results.

Causality direction	M = 5	M=10	M=15	M=20
		Q_1		
S&P 500-ISE 100	0.364	0.354	0.082	-0.172
ISE 100 – S&P 500	0.909	1.088	1.001	0.945
TCELL - TKC	0.528	0.127	-0.169	-0.355
TKC - TCELL	0.004	0.041	-0.125	-0.177
S&P 500 - TKC	-0.426	-0.545	-0.684	-0.803
TKC – S&P 500	-0.228	0.062	0.070	0.125
ISE 100 - TCELL	-0.946	-0.893	-0.613	-0.163
TCELL - ISE 100	1.338	0.632	0.220	-0.042
S&P 500 - TCELL	0.066	1.107	1.213	1.137
TCELL - S&P 500	0.340	0.260	0.188	0.203
ISE 100 - TKC	0.232	0.310	0.192	0.050
TKC - ISE 100	0.704	0.464	0.179	0.088

Notes: * and ** indicates significant causality relationship effect at 1 and 5% level respectively.

Table 8. The augmented EGARCH model results.

	ISE 100	S&P 500	TKC	TCELL
Constant	0.023	0.017	0.006	-0.003
AR(1)	-1.048*	0.687*	0.674*	-0.509*
AR(2)	-0.054*	-0.973*	0.062**	0.078
AR(3)	-	0.452*		0.803*
MA(1)	0.978*	-0.768*	-0.792*	0.436*
MA(2)	-0.026*	0.996*		-0.170*
MA(3)		-0.504*		-0.878*
S&P 500_{t-1}	0.208*		0.052**	0.092*
ISE 100_{t-1}				
$TCELL_{t-1}$			0.107**	
TKC $_{t-1}$	0.097*			0.208*
ω	-0.153*	-0.051*	-0.103*	-0.265*
α_1	0.171*	-0.288*	0.136*	0.332*
α_2		0.344*		
β	0.842*	0.916*	0.907*	0.794*
γ	-0.081*	-0.119*	-0.046**	0.011
v	1.415*	1.601*	1.216*	1.286*
Log-lik	-2617.209	-2701.803	-2681.902	-2595.629
ARCH (5)	0.075 [0.995]	1.137 [0.338]	0.280 [0.924]	1.351 [0.239]
Q (20)	-0.006 [0.750]	0.013 [0.039]	-0.012 [0.276]	-0.030 [0.097]
Q_S *(20)*	0.002 [0.985]	0.003 [0.151]	-0.038 [0.448]	0.003 [0.003]

Notes: *v* indicates GED parameter, Log-lik indicates Loglikelihood value, ARCH(5) indicates LM conditional variance test, Q(20) and Q_S(20) indicates Box-Pierce serial correlation test for return and squared return series respectively. *, ** and *** indicates significance levels at 1%, 5% and 10%, respectively.

noted that among volatility variables, there is no causality relationship among variance of variables.

In order to find out the direction and size of the causality relation between variables, Bhar and Hamori (2005) employed augmented the GARCH model. For this reason, they add lags of variables in to the mean and variance equation of GARCH models according to causality test results. Following to same approach we reestimate EGARCH to determine direction and size of the causality relation. According to results in Table 8, an increase in S&P 500 index return lead to raise ISE 100, TKC and TCELL. TCELL and TKC influence each other and an increase in TKC cause to raise TCELL vice versa.

Conclusion

In this study, the causality relationship between the returns and the variances of Turkcell which is traded as ADR at USA securities markets is investigated. For this reason, two-step test method developed by Hong (2001) is used to analyze the causality relationship between return series of Turkcell. As the two-step causality test is affected by structural break, the existence of the structural break is also tested. According to the break test results, there are 3 breaks at ISE 100 index, 6 at S&P 500 index, 4 at TKC and 2 at TCELL. Returns series are filtered by determined break dates and for the causality test, the filtered series are used. At the first step of the causality test, the return series are estimated with EGARCH model and the standardized residuals are obtained. In the second step of the causality test, cross correlation function is computed between the standardized residuals. According to the causality test results, S&P 500 index is found as Granger cause of ISE 100 index, TKC and TCELL. There is a strong feedback effect between TKC and TCELL and as a result, these variables affect each other. The causality-in-variance results indicate no causality relationship between variables.

Finally, augmented EGARCH is employed to determine direction of causality relationship between variables. When the results are evaluated generally, ISE 100 index and TCELL index are affected from US stock market movements. In order to increase portfolio return, investors should consider causality relationship in price formation and get benefit from investing ISE 100 index and specifically in TCELL stocks.

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